

Preface

Nanomaterial is one of the hottest fields in nanotechnology that studies fabrication, characterization, and analysis of materials with morphological features on the nanoscale in at least one dimension. Recent progress in synthesis and fundamental understanding of properties of nanomaterial has led to significant advancement of nanomaterial-based gas/chemical/biological sensors. The most important aspect of nanomaterial is their special properties associated with nanoscale geometries. The most fundamental characteristic of nanomaterial is the high surface area to volume ratio, which results in a number of unusual physical and chemical properties such as high molecular adsorption, large surface tension force, enhanced chemical and biological activities, large catalytic effects, and extreme mechanical strength, but another unique property of nanomaterial and recently most studied is the quantum size effect that leads to their discrete electronic band structure like those of molecules. This quantum property of nanomaterial can lead to an extraordinary high sensitivity and selectivity of biosensors and can be benefit to the field of diagnostics.

In this book, we focus on a wide range of nanomaterials including nanoparticles, quantum dots, carbon nanotubes, molecularly imprinted nanostructures or plati-bodies, nanometal, DNA-based structures, smart nanomaterials, nanoprobles, magnetic nanomaterials, organic molecules such as phthalocyanines and porphyrins, and the most amazing novel nanomaterial called graphene, for various gas/chemical/biological sensing applications. Moreover, perspectives of new sensing techniques such as nanoscaled electrochemical detection, functional nanomaterial-amplified optical assay, colorimetric fluorescence, and electrochemiluminescence are reviewed and extensively explained. This book includes recent progress of selected nanomaterials over a broad range of gas/chemical/biological sensing applications, and examples of nanomaterials in sensing and diagnostic application are given.

The use of biofunctional nanomaterials in signal amplification for ultrasensitive biosensing is extensively discussed. The biofunctional nanomaterials with the abilities of specific recognition and signal triggering can be employed as not only

excellent carriers but also electronic and optical signal tags to amplify the detection signal. Nanomaterial-based electroanalytical biosensors are discussed to give some ideas and concepts of utilizing nanomaterials for cancer and bone disease diagnostics. Then, new nanomaterial-based electrochemical impedance biosensors applied in cancer and bone disease studies that can detect in real time without any pre-labeling specific biomolecules at previously unattainable ultra-low concentrations are specifically discussed. The hottest area of nanomaterial called “carbon nanomaterial” including carbon nanotube and graphene is up-to-date reviewed. Carbon nanotube-based chemical and biosensors and its integration to microfluidic systems are discussed. Carbon nanotube-based electrochemical sensors integrated into microfluidic systems are extensively surveyed and discussed. Moreover, a comprehensive review of graphene-based chemical and biosensors will help who interests to springboard to the new area of carbon nanomaterial-based sensors more easily. Graphene’s synthesis methods, properties, and different types of chemical and biosensors including chemoresistive, electrochemical, and other sensing platforms are described. Newly invented organic nanomaterials such as molecularly imprinted polymers (MIPs) are expansively reviewed and analyzed for sensing and diagnostics of various biological species. Inorganic nanomaterials such as nanometal structures using in localized surface plasmon resonance (LSPR) biosensor platform are discussed including their biomedical diagnosis applications. Naturally derived nanomaterial-based sensors such as DNA sensors (genosensors) employing nanomaterials are extensively described. As quantum effect of nanomaterial is amazing, novel nanoprobe for in vivo cell tracking used for evaluating the therapeutic efficacy will show the potential of this quantum effect for diagnostics. Another organic nanomaterials made of metallo-porphyrin (MP) and metallo-phthalocyanine (MPc) which are optically active are used in optical-based gas sensors and electronic nose systems. Then, this book concludes with the uses of nanotechnology to attain highly sensitive detection in electrochemical microdevices. Issues relating to miniaturization of electrochemical electrode and system are discussed. Various techniques applicable to fabrication and integration of nanoelectrodes are included. With the extensive review of newly discovered nanomaterials used for sensors and diagnostics, this book will be interesting not only for scientists working in the field of nanomaterial-based sensor technology but also for students studying analytical chemistry, biochemistry, electrochemistry, material science, and micro- and nanotechnology.

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